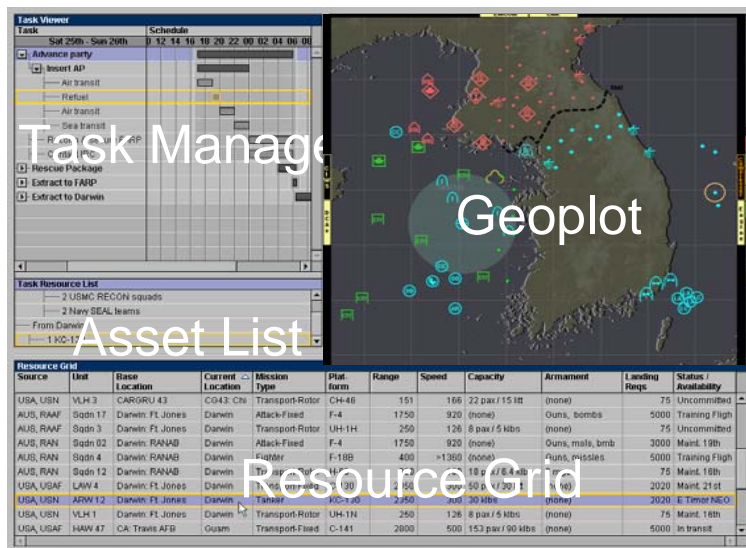


Some Human Factors Design Principles for Effective Visualization and Collaboration of Military Operations



SPAWAR

Systems Center
San Diego



Report Documentation Page				Form Approved OMB No. 0704-0188	
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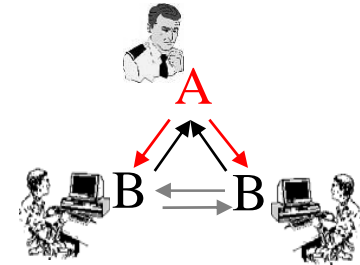
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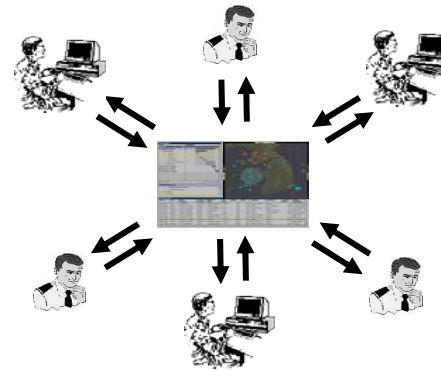


Collaboration in Military Command and Control

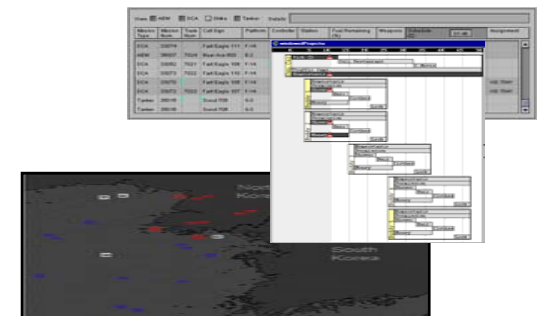
- ◆ Interactions are hierarchical and distributed
 - Need information sharing and plan coordination



- ◆ Interactions are asynchronous
 - Need intervening representations



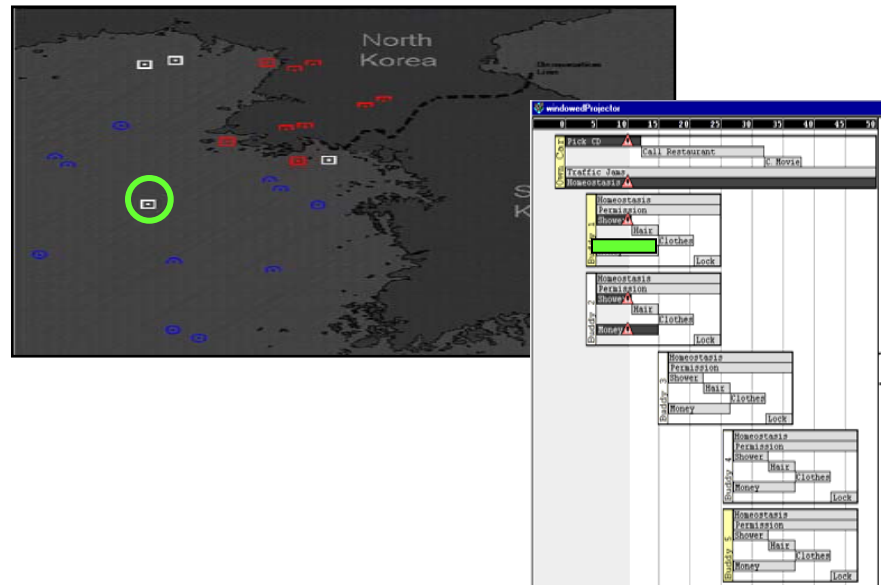
- ◆ Plans are complex and many dimensional
 - Goals, tasks, assets, priorities, schedules...
 - Need information visualization and integration



Architecture Principle: Slice & Link

- ◆ Use multiple “2D” displays
 - Geoplot
 - Assets by location
 - Task Manager
 - Tasks by time
 - Resource Grid
 - Assets by attribute
 - Etc.
- ◆ Use Dynamic Visual Linking
 - “Content addressable memory”

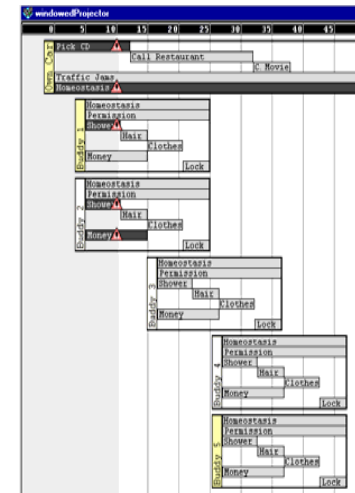
View: <input checked="" type="checkbox"/> AEW <input checked="" type="checkbox"/> DCA <input type="checkbox"/> Strike <input checked="" type="checkbox"/> Tanker Details: _____										
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
DCA	33074		Fast Eagle 111	F-14	BW	(assigned)	100	2 2 0	2330 - 0200	
AEW	36007	7024	Bear Ace 800	E-2	BW	Albany	80	0 0 0	0030 - 0200	
DCA	33052	7021	Fast Eagle 106	F-14	BW-D	San Diego	75	2 1 0	0030 - 0200	
DCA	33073	7022	Fast Eagle 110	F-14	BW-D	San Diego	75	2 1 0	0030 - 0200	
DCA	33072	7023	Fast Eagle 107	F-14	BW-T	Newport	50	1 1 1	0030 - 0200	VID 7041
Tanker	35015		Scout 705	S-3	BR	Houston	100	0 0 0	0030 - 0200	
Tanker	35016		Scout 706	S-3	BR	(assigned)	100	0 0 0	0030 - 0200	



“2D” Display Design

◆ Task Manager

- Task by time
- Schedules
- Dependencies
- Implications of delays
- Etc.



◆ Resource Grid

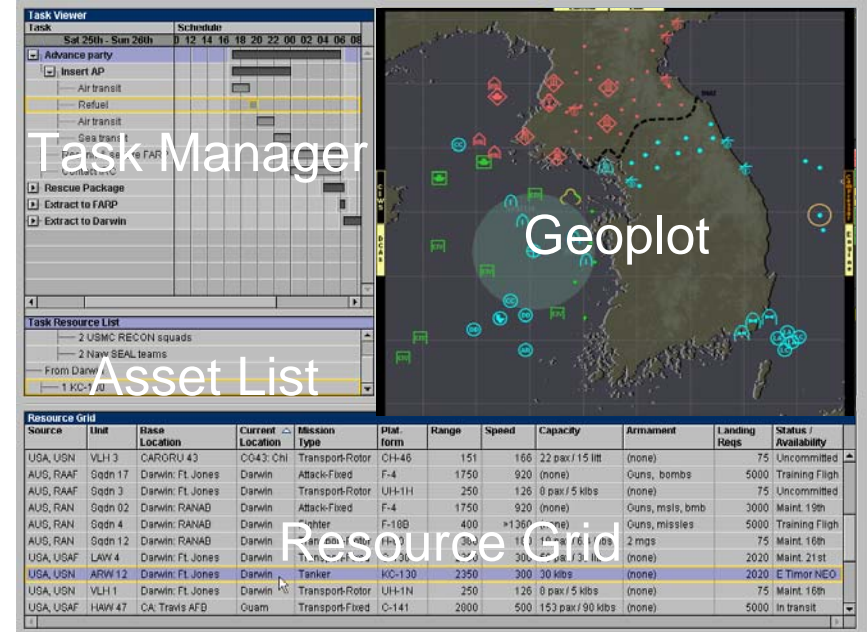
- Assets by attributes
- Sort, filter, retrieve, compare assets and their attributes

View: <input checked="" type="checkbox"/> AEW <input checked="" type="checkbox"/> DCA <input type="checkbox"/> Strike <input type="checkbox"/> Tanker Details: _____										
Mission Type	Mission Num	Trak Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
DCA	33074		Fast Eagle 111	F-14	BW	(assigned)	100	2 2 0	2330 - 0200	
AEW	36007	7024	Bear Ace 500	E-2	BW	Albany	80	0 0 0	0030 - 0200	
DCA	33052	7021	Fast Eagle 106	F-14	BW-D	San Diego	75	2 1 0	0030 - 0200	
DCA	33073	7022	Fast Eagle 110	F-14	BW-D	San Diego	75	2 1 0	0030 - 0200	
DCA	33070		Fast Eagle 105	F-14	BW-T	Newport	50	1 1 1	0030 - 0200	VID 7041
DCA	33072	7023	Fast Eagle 107	F-14	BW-T	Newport	50	1 1 1	0030 - 0200	VID 7041
Tanker	35015		Scout 705	S-3	BR	Houston	100	0 0 0	0030 - 0200	
Tanker	35016		Scout 706	S-3	BR	(assigned)	100	0 0 0	0030 - 0200	

PSYCLOPS

A Single Integrated “Eye” on the Situation

- ◆ Integrated Tools to Augment Command and Control
 - More effective situation and plan visualization tools with
 - Visually interlinked databases for content addressable memory and context tracking
- ◆ Linked components
 - Task Manager
 - Task components and schedule
 - Resource Grid
 - Asset data and availability
 - Asset List
 - Correlation of assets to tasks
 - Geoplot
 - Locations of assets

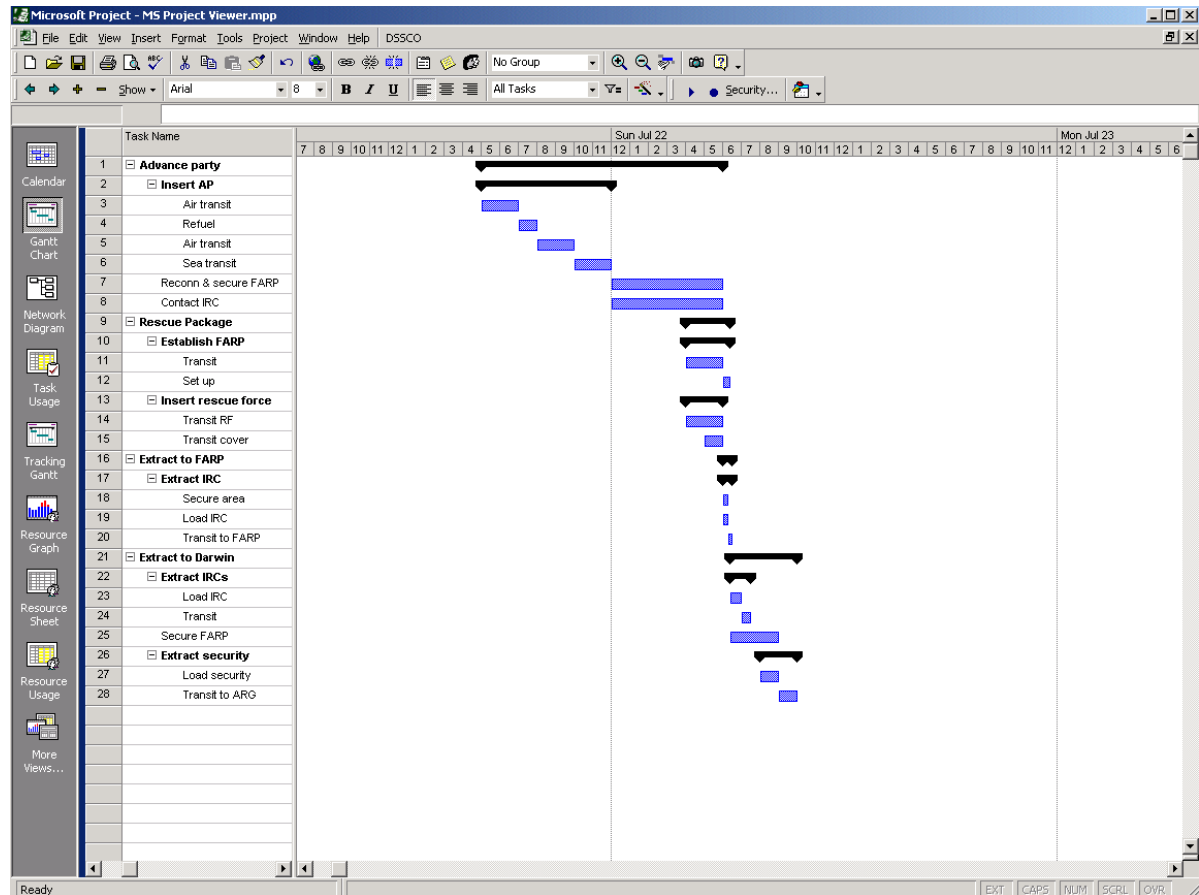


Example Scenario: NEO in East Timor

- ◆ Noncombatant Evacuation Operation
 - CH-53s, CH-46s, KC-130s, AC-130s, MC-130s, AV-8Bs, AH-1s, USMC RECON teams, Navy SEAL teams, Medical corps teams
- ◆ Evacuate approx. 50 Red Cross workers from rebel-held territory in East Timor
- ◆ Work with local embassy to develop an evacuation plan
- ◆ Insert advance forces to recon and secure staging areas
- ◆ Insert main body rescue force
- ◆ Extract Red Cross workers and the rescue force

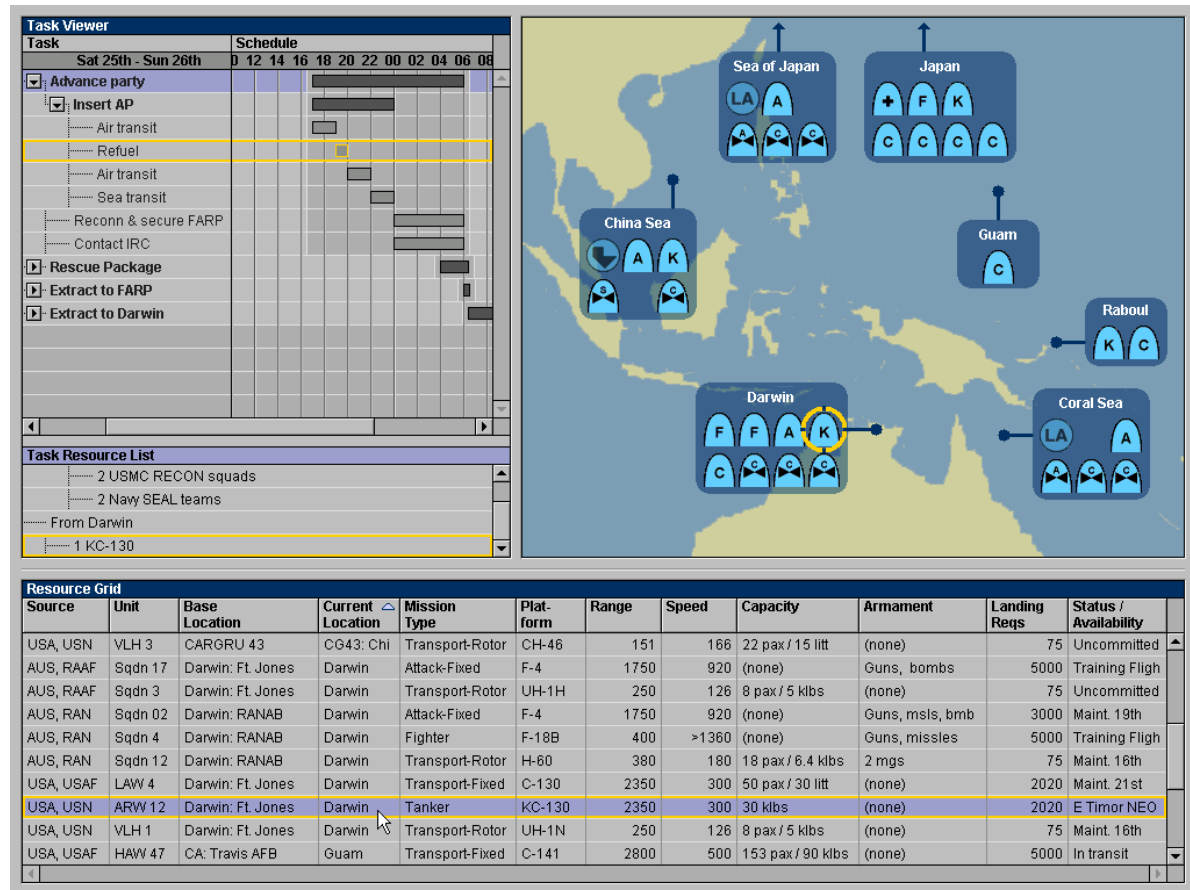
NEO with Current Tools

- ◆ Are there Darwin-based tasks or resources?
- ◆ What would it mean if there were?
- ◆ Do I need to reassign anything?
- ◆ How will I find replacement resources?
- ◆ Which tasks need rescheduling?



NEO with PSYCLOPS

- ◆ Are there Darwin-based tasks or resources?
- ◆ What would it mean if there were?
- ◆ Do I need to reassign anything?
- ◆ How will I find replacement resources?
- ◆ Which tasks need rescheduling?



The map shows the following wreck distributions:

- China Sea:** One wreck with a downward arrow, one 'A' type, one 'K' type, one 'S' type, and one 'C' type.
- Guam:** One 'C' type wreck.
- Raboul:** One 'K' type and one 'C' type wreck.
- Darwin:** One 'F' type, one 'A' type, one 'K' type, one 'C' type, and three wrecks with a cross symbol.
- Coral Sea:** One 'LA' type, one 'A' type, and three wrecks with a cross symbol.

Task Resource List	

Resource Grid												
Source 	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability	
USA, USAF	HAW 47	CA: Travis AFB	Guam	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	In transit	
USA, USAF	HAW 23	Okinawa	Okinawa	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	Team Spirit	
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st	
USA, USAF	MAW 8	Kadena AB: Japan	Kadena	Transport-Fixed	C-17	2760	390	102 pax / 90 klbs	(none)	4700	Team Spirit	
USA, USAF	MAW 3	Yokota AB: Japan	Yokota	Transport-Fixed	C-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit	
USA, USMC	AW 3	Okinawa	Okinawa	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit	
USA, USN	VAS 22	CARGRU 43	CG43: Chi	ASW-Rotor	SH-60	150	155	3 torp	3 torpedos	75	Uncommitted	
USA, USN	TF 33	ARG: Belleau Wood	ARG: Coral	Attack-Fixed	AV-8B	800	630	(none)	Guns, msls, bmb	100	E Timor NEO	
USA, USN	TF 57	ARG: Tarawa	ARG: Sea	Attack-Fixed	AV-8B	800	630	(none)	Guns, msls, bmb	75	Team Spirit	
USA, USN	TF 33	ARG: Belleau Wood	ARG: Coral	Attack-Rotor	AH-1	317	173	(none)	Guns, msls, bmb	75	E Timor NEO	
 												

Sort RG by Base Location

Note Darwin-based asset



Resource Grid											
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqdn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Flight
AUS, RAAF	Sqdn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
AUS, RAN	Sqdn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msIs, bmb	3000	Maint. 19th
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missiles	5000	Training Flight
AUS, RAN	Sqdn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mgs	75	Maint. 16th
USA, USN	MAW 2	GUAM:NAB	Rabaul	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Training Flight

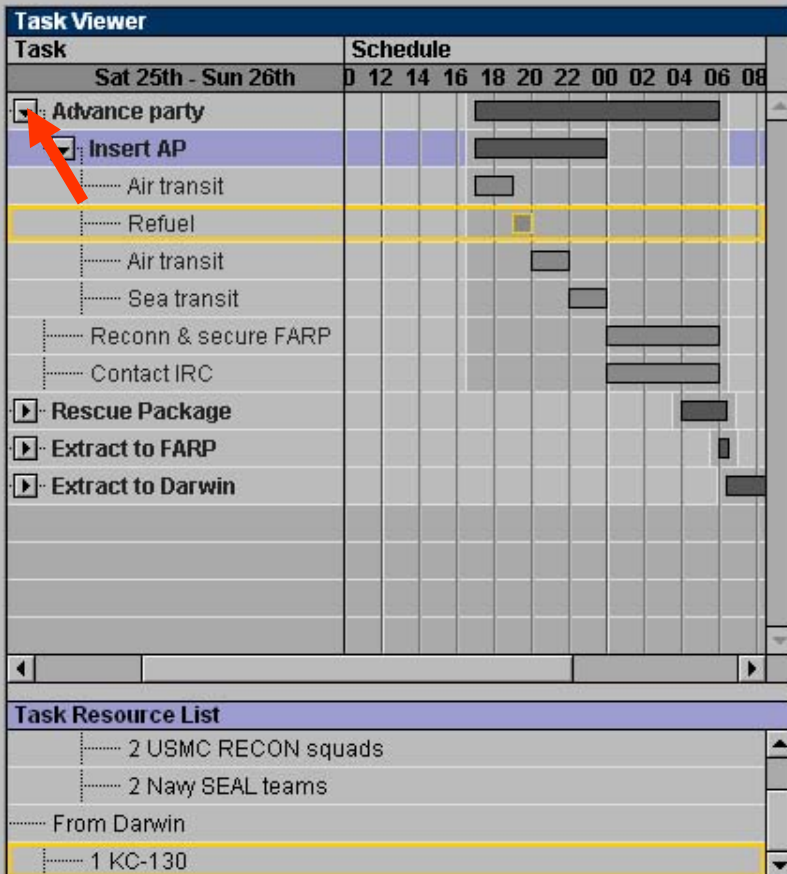
Select Darwin-based asset DVL to geoplots and TM



Resource Grid											
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqdn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Flight
AUS, RAAF	Sqdn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
AUS, RAN	Sqdn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msIs, bmb	3000	Maint. 19th
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missiles	5000	Training Flight
AUS, RAN	Sqdn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mgs	75	Maint. 16th
USA, USN	MAW 2	GUAM:NAB	Rabaul	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Training Flight

Expand “Advance Party” task

Refueling task is soon!



Resource Grid											
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USN	VLH 3	CARGRU 43	CG43: Chi	Transport-Rotor	CH-46	151	166	22 pax / 15 litt	(none)	75	Uncommitted
AUS, RAAF	Sqdn 17	Darwin: Ft. Jones	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, bombs	5000	Training Flight
AUS, RAAF	Sqdn 3	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1H	250	126	8 pax / 5 klbs	(none)	75	Uncommitted
USA, USAF	LAW 4	Darwin: Ft. Jones	Darwin	Transport-Fixed	C-130	2350	300	50 pax / 30 litt	(none)	2020	Maint. 21st
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	VLH 1	Darwin: Ft. Jones	Darwin	Transport-Rotor	UH-1N	250	126	8 pax / 5 klbs	(none)	75	Maint. 16th
AUS, RAN	Sqdn 02	Darwin: RANAB	Darwin	Attack-Fixed	F-4	1750	920	(none)	Guns, msls, bmb	3000	Maint. 19th
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missiles	5000	Training Flight
AUS, RAN	Sqdn 12	Darwin: RANAB	Darwin	Transport-Rotor	H-60	380	180	18 pax / 6.4 klbs	2 mgs	75	Maint. 16th
USA, USN	MAW 2	GUAM:NAB	Rabaul	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Training Flight

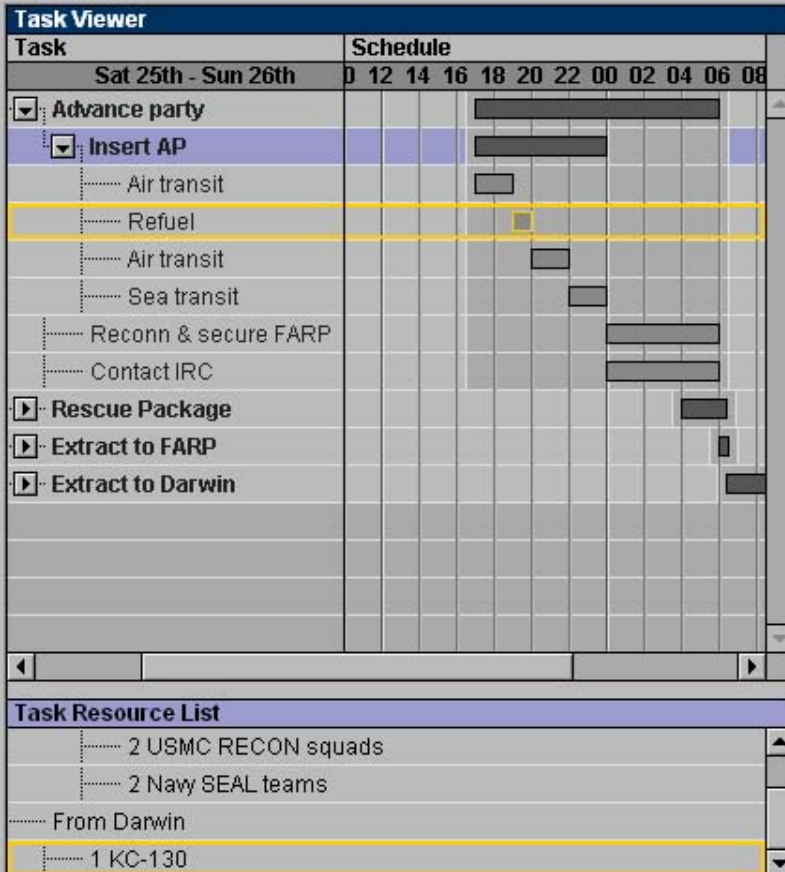
Sort by Mission Type to look for alternative tankers



Task Viewer	
Task	Schedule
Sat 25th - Sun 26th	0 12 14 16 18 20 22 00 02 04 06 08
<input checked="" type="checkbox"/> Advance party	
<input checked="" type="checkbox"/> Insert AP	
Air transit	
Refuel	
Air transit	
Sea transit	
Reconn & secure FARP	
Contact IRC	
<input checked="" type="checkbox"/> Rescue Package	
<input checked="" type="checkbox"/> Extract to FARP	
<input checked="" type="checkbox"/> Extract to Darwin	
Task Resource List	
2 USMC RECON squads	
2 Navy SEAL teams	
From Darwin	
1 KC-130	

Resource Grid											
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USAF	HAW 23	Okinawa	Okinawa	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	Team Spirit
USA, USMC	AW 3	Okinawa	Okinawa	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USAF	MAW 3	Yokota AB: Japan	Yokota	Transport-Fixed	C-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	CARGRU 43	CG43: Chi	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	ARW 12	Rabaul: Ft. Smith	Rabaul	Tanker	KC-130	2350	300	30 klbs	(none)	2020	Training Flight
USA, USN	ARW 12	Yokota AB: Japan	Yokota	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Uncommitted
USA, USN	VF 34	CARGRU 43	CG43: Chi	Fighter	F/A-18	575	>1360	(none)	Guns, msls, bmb	5000	Uncommitted
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missiles	5000	Training Flight
USA, USAF	FW 34	Kadena AB: Japan	Kadena	Fighter	F-15D	3450	1875	(none)	20 mm, 8 missiles	5000	Team Spirit

Rabaul-based tanker is available

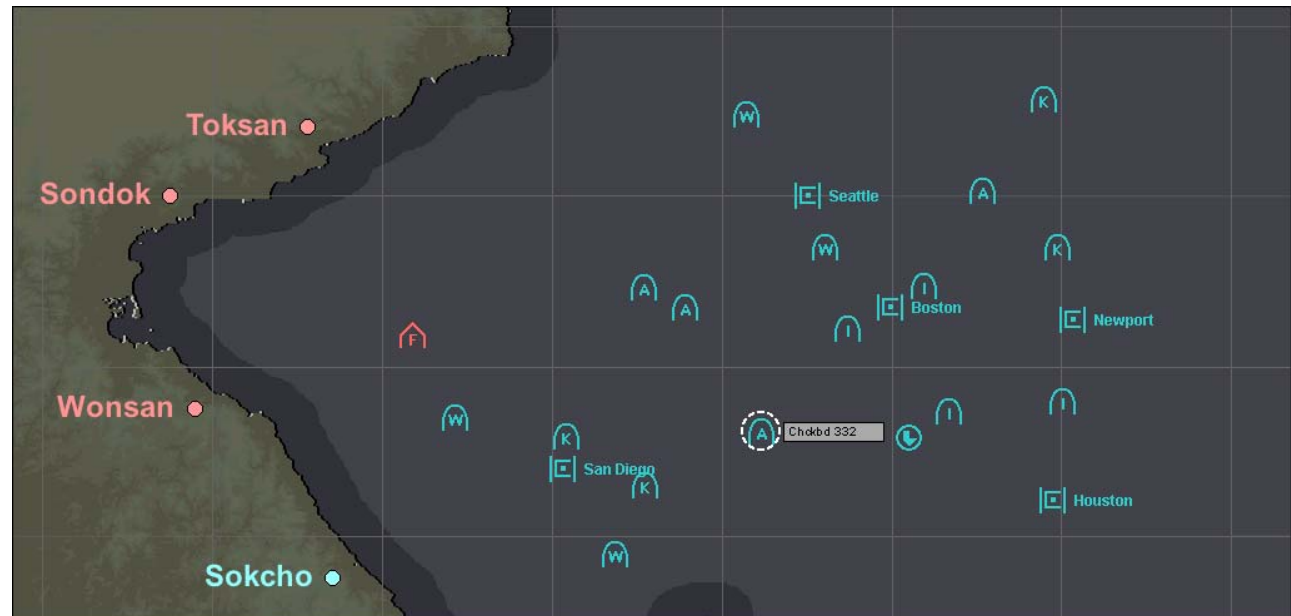


Resource Grid											
Source	Unit	Base Location	Current Location	Mission Type	Platform	Range	Speed	Capacity	Armament	Landing Reqs	Status / Availability
USA, USAF	HAW 23	Okinawa	Okinawa	Transport-Fixed	C-141	2800	500	153 pax / 90 klbs	(none)	5000	Team Spirit
USA, USMC	AW 3	Okinawa	Okinawa	Transport-Fixed	MC-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USAF	MAW 3	Yokota AB: Japan	Yokota	Transport-Fixed	C-130	2350	300	74 pax / 25 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	CARGRU 43	CG43: Chi	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Team Spirit
USA, USN	ARW 12	Darwin: Ft. Jones	Darwin	Tanker	KC-130	2350	300	30 klbs	(none)	2020	E Timor NEO
USA, USN	ARW 12	Rabaul: Ft. Smith	Rabaul	Tanker	KC-130	2350	300	30 klbs	(none)	2020	Training Flight
USA, USN	ARW 12	Yokota AB: Japan	Yokota	Tanker	KC-130	2800	300	30 klbs	(none)	2020	Uncommitted
USA, USN	VF 34	CARGRU 43	CG43: Chi	Fighter	F/A-18	575	>1360	(none)	Guns, msls, bmb	5000	Uncommitted
AUS, RAN	Sqdn 4	Darwin: RANAB	Darwin	Fighter	F-18B	400	>1360	(none)	Guns, missiles	5000	Training Flight
USA, USAF	FW 34	Kadena AB: Japan	Kadena	Fighter	F-15D	3450	1875	(none)	20 mm, 8 missiles	5000	Team Spirit

Plans, Assets, & Attributes

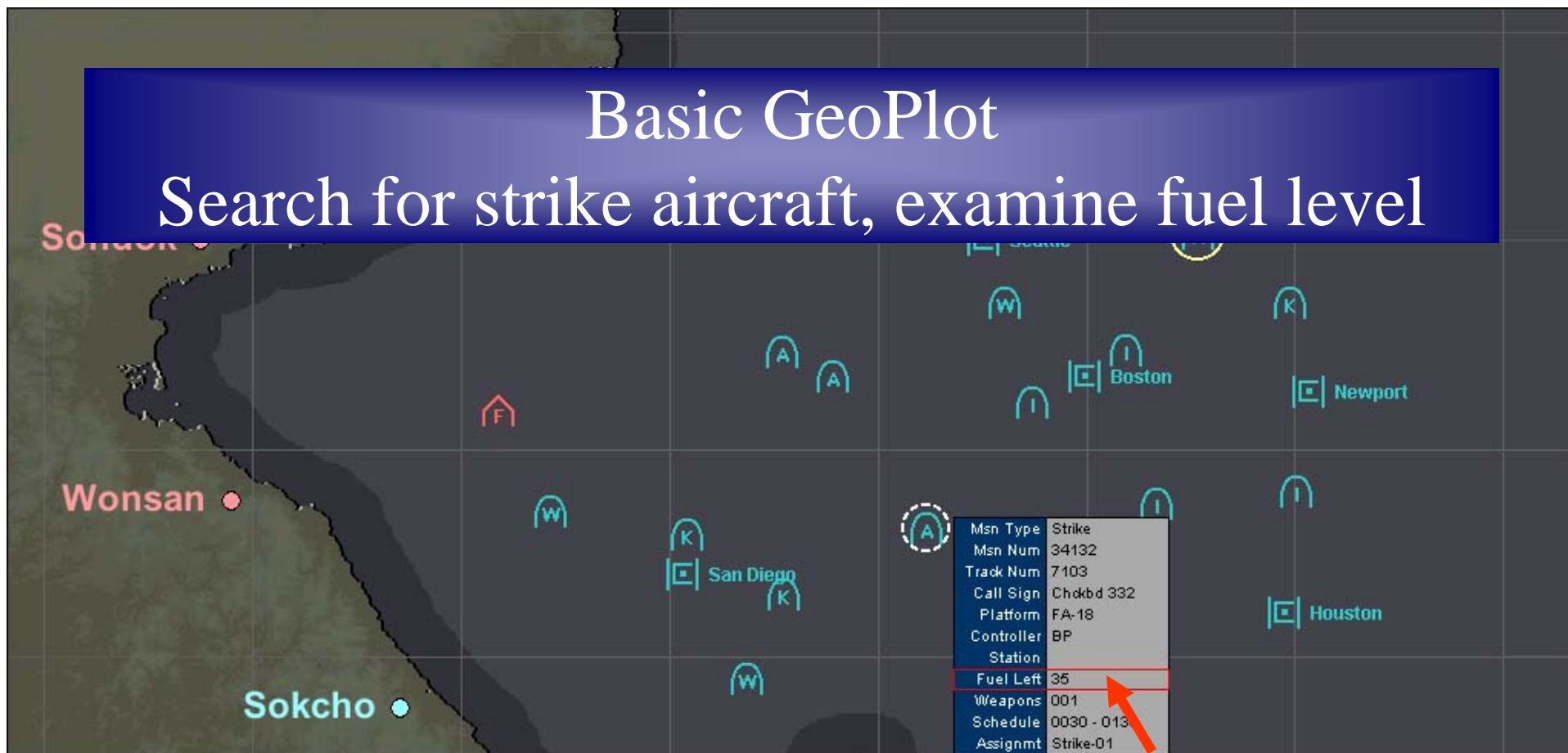
- ◆ It is difficult to keep track of assets and their status
 - Distilled and organized from multiple sources
- ◆ It is difficult to compare the attributes of assets
- ◆ It can even be difficult to find assets

Where is the
interceptor with
the least fuel?



Basic GeoPlot

Search for strike aircraft, examine fuel level



Where is the Strike aircraft with the lowest fuel level?

Basic GeoPlot

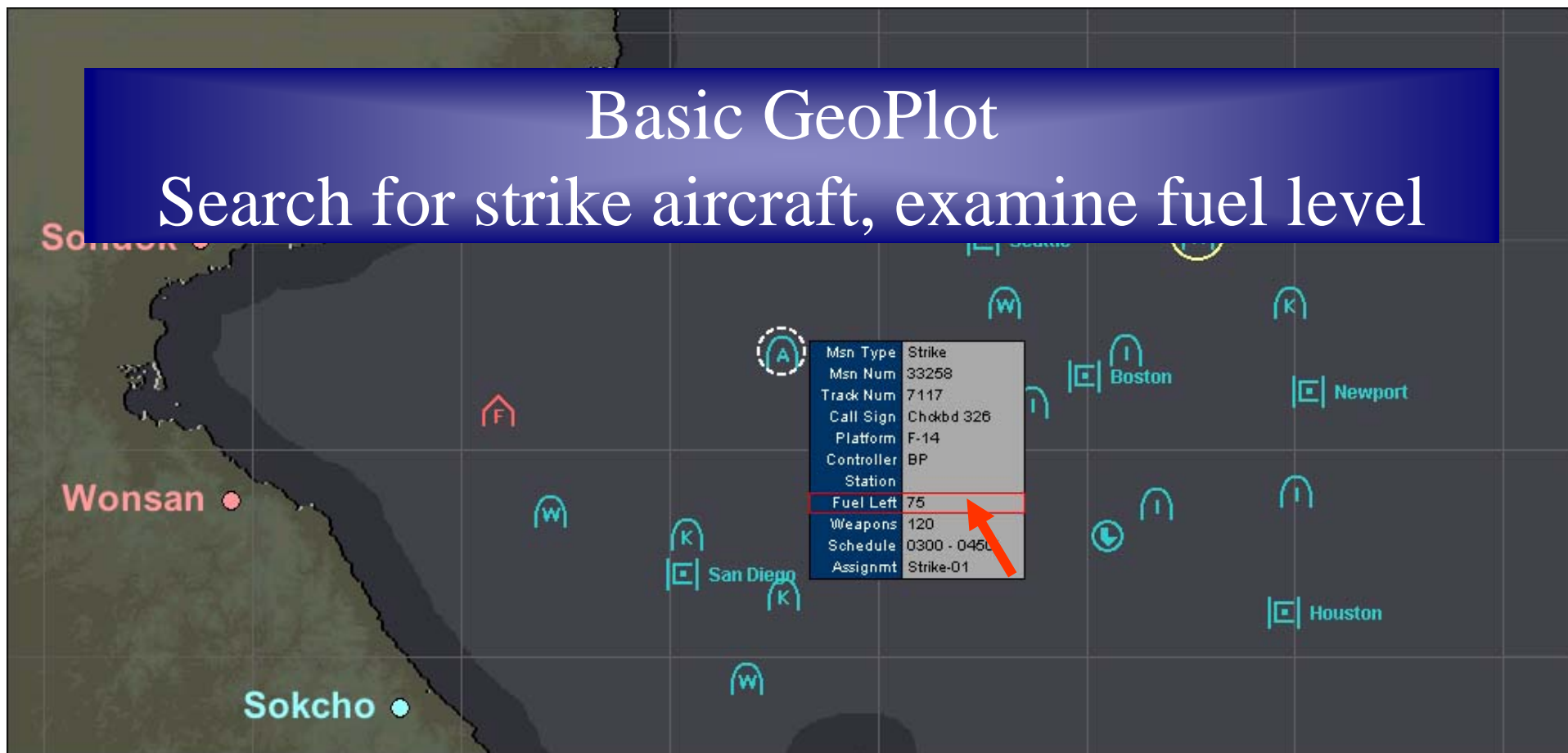
Search for strike aircraft, examine fuel level



Where is the Strike aircraft with the lowest fuel level?

Basic GeoPlot

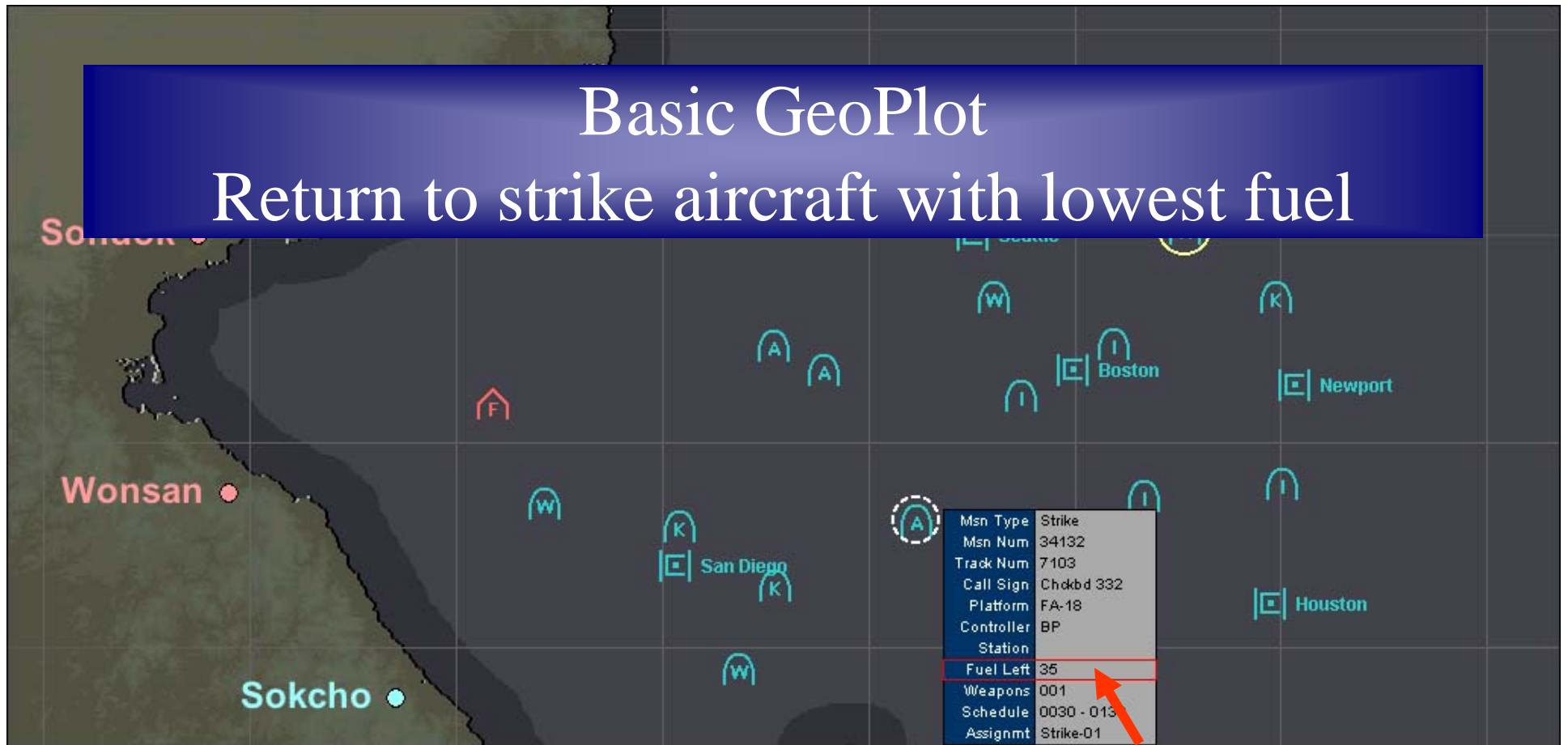
Search for strike aircraft, examine fuel level



Where is the Strike aircraft with the lowest fuel level?

Basic GeoPlot

Return to strike aircraft with lowest fuel



Where is the Strike aircraft with the lowest fuel level?

RG: Method 1

Select a filter for all mission types



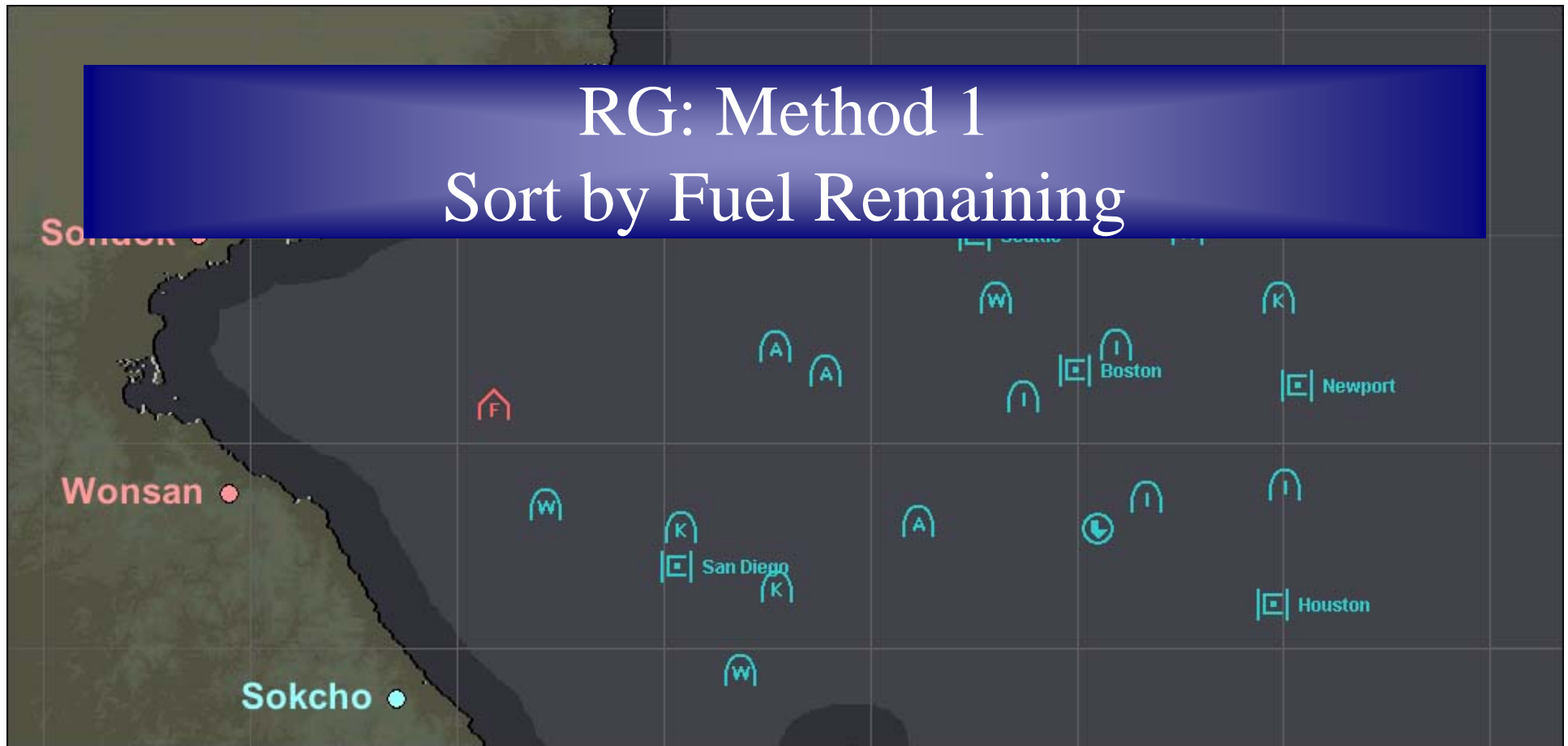
View: ☒ AEW ☒ DCA ☒ Strike ☒ Tanker

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	03:00	Assignment
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300		
AEW	36105		Bear Ace 603	E-2	BW	San Diego	80	000	0300 - 0450		
AEW	36138	7187	Bear Ace 610	E-2	BW	Seattle	75	000	0120 - 0220		
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300		
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400		
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300		
DCA	33138		Fast Eagle 102	F-14	BW-T	Boston	90	020	0230 - 0330		
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		

Where is the Strike aircraft with the lowest fuel level?

RG: Method 1

Sort by Fuel Remaining



View: ☒ AEW ☒ DCA ☒ Strike ☒ Tanker

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	03:00	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300		
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300		
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400		
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450		
Strike	34132	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130		Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400		
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300		

Where is the Strike aircraft with the lowest fuel level?

RG: Method 1

Roll down looking for a strike aircraft



View: ☒ AEW ☒ DCA ☒ Strike ☒ Tanker

DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	03:00	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450		
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300		
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300		
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400		
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450		
Strike	34132	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130		Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400		
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300		

Where is the Strike aircraft with the lowest fuel level?

RG: Method 1

Roll down looking for a strike aircraft



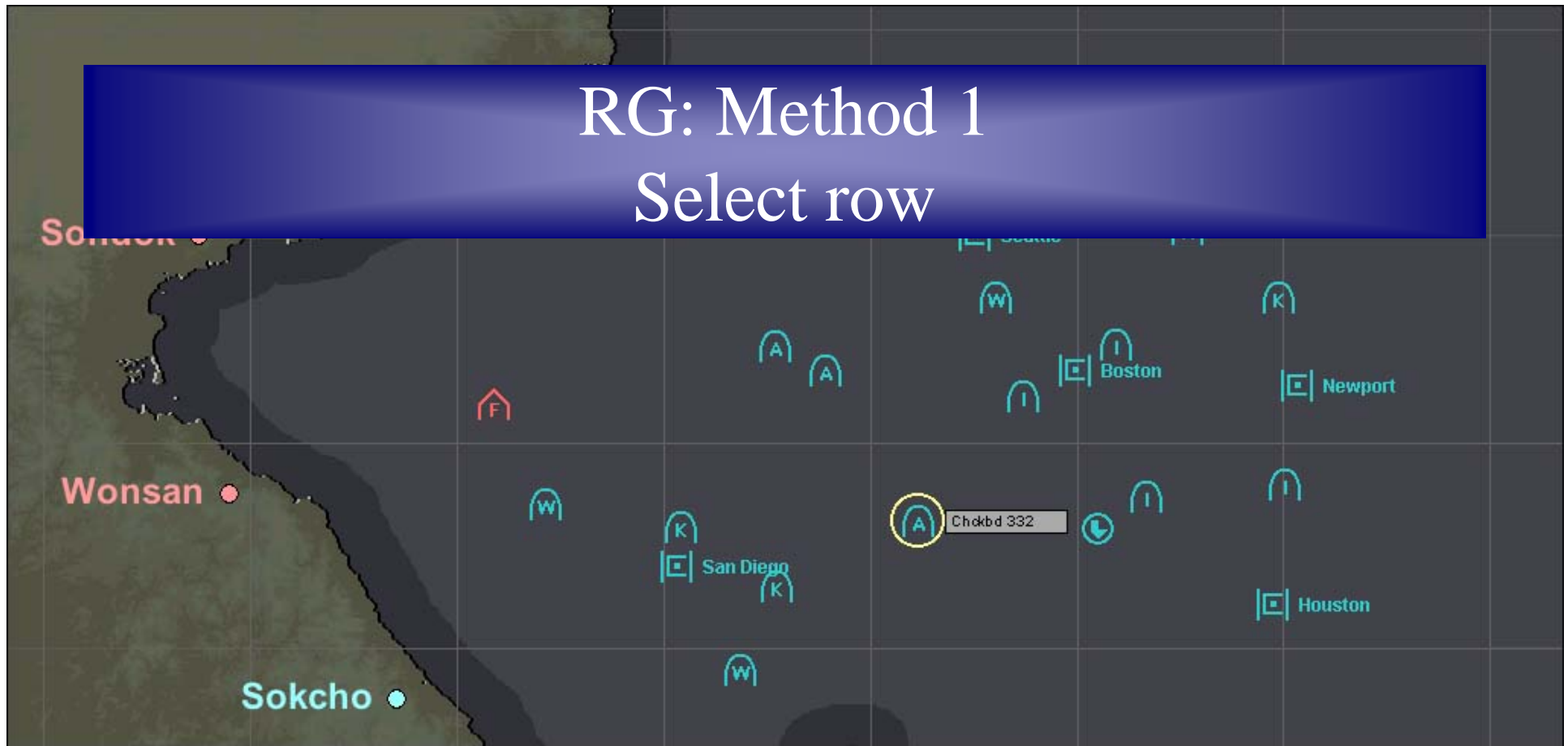
View: ☒ AEW ☒ DCA ☒ Strike ☒ Tanker

Strike	34132	7103	Chckbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450	
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300	
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300	
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400	
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450	
Strike	34132	7103	Chckbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400	
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300	

Where is the Strike aircraft with the lowest fuel level?

RG: Method 1

Select row



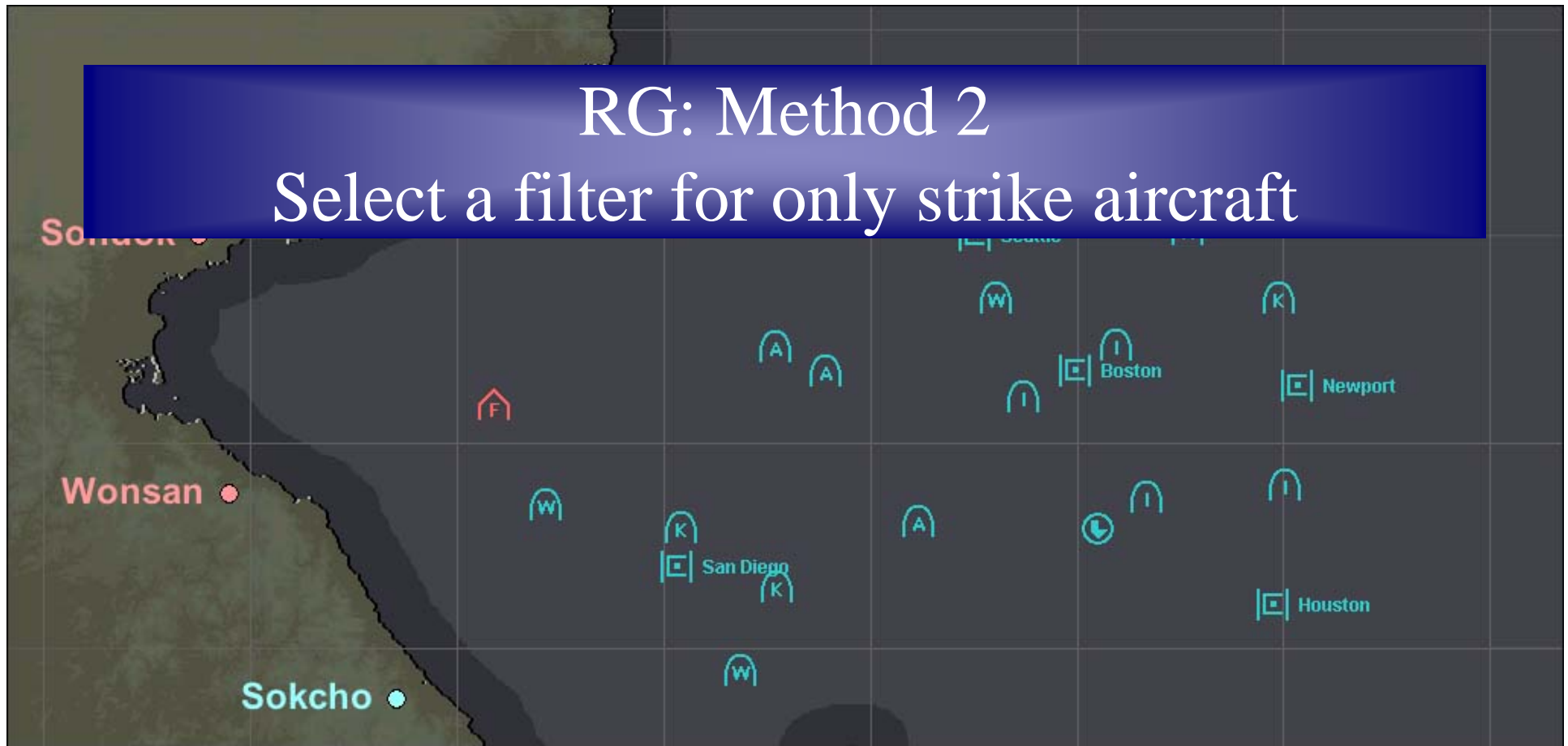
View: ☒ AEW ☒ DCA ☒ Strike ☒ Tanker

Strike	34132	7103	Chkcbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01
Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
DCA	33202		Fast Eagle 104	F-14	BW-T	Boston	10	122	0300 - 0450	
DCA	33124		Fast Eagle 110	F-14	BW-D	Newport	20	210	0120 - 0300	
AEW	36087	7155	Bear Ace 602	E-2	BW	San Diego	20	000	0130 - 0300	
Tanker	35066		Scout 706	S-3	BR	Seattle	30	000	0230 - 0400	
Tanker	35093		Scout 701	S-3	BR	Boston	30	000	0300 - 0450	
Strike	34132	7103	Chkcbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01
DCA	33218	7098	Fast Eagle 106	F-14	BW-D	Newport	40	222	0230 - 0400	
AEW	36130		Bear Ace 611	E-2	BW	Seattle	50	000	0130 - 0300	

Where is the Strike aircraft with the lowest fuel level?

RG: Method 2

Select a filter for only strike aircraft



View: ☐ AEW ☐ DCA ☒ Strike ☐ Tanker

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
Strike	33258	7117	Chokbd 326	F-14	BP		75 <div><div></div></div>	120	0300 - 0450	Strike-01
Strike	33118		Chokbd 327	F-14	BP		70 <div><div></div></div>	111	0230 - 0400	Strike-01
Strike	34067	7154	Chokbd 331	FA-18	BP		65 <div><div></div></div>	122	0130 - 0330	Strike-01
Strike	34132	7103	Chokbd 332	FA-18	BP		35 <div><div></div></div>	001	0030 - 0130	Strike-01

Where is the Strike aircraft with the lowest fuel level?

RG: Method 2

Roll down looking for lowest fuel



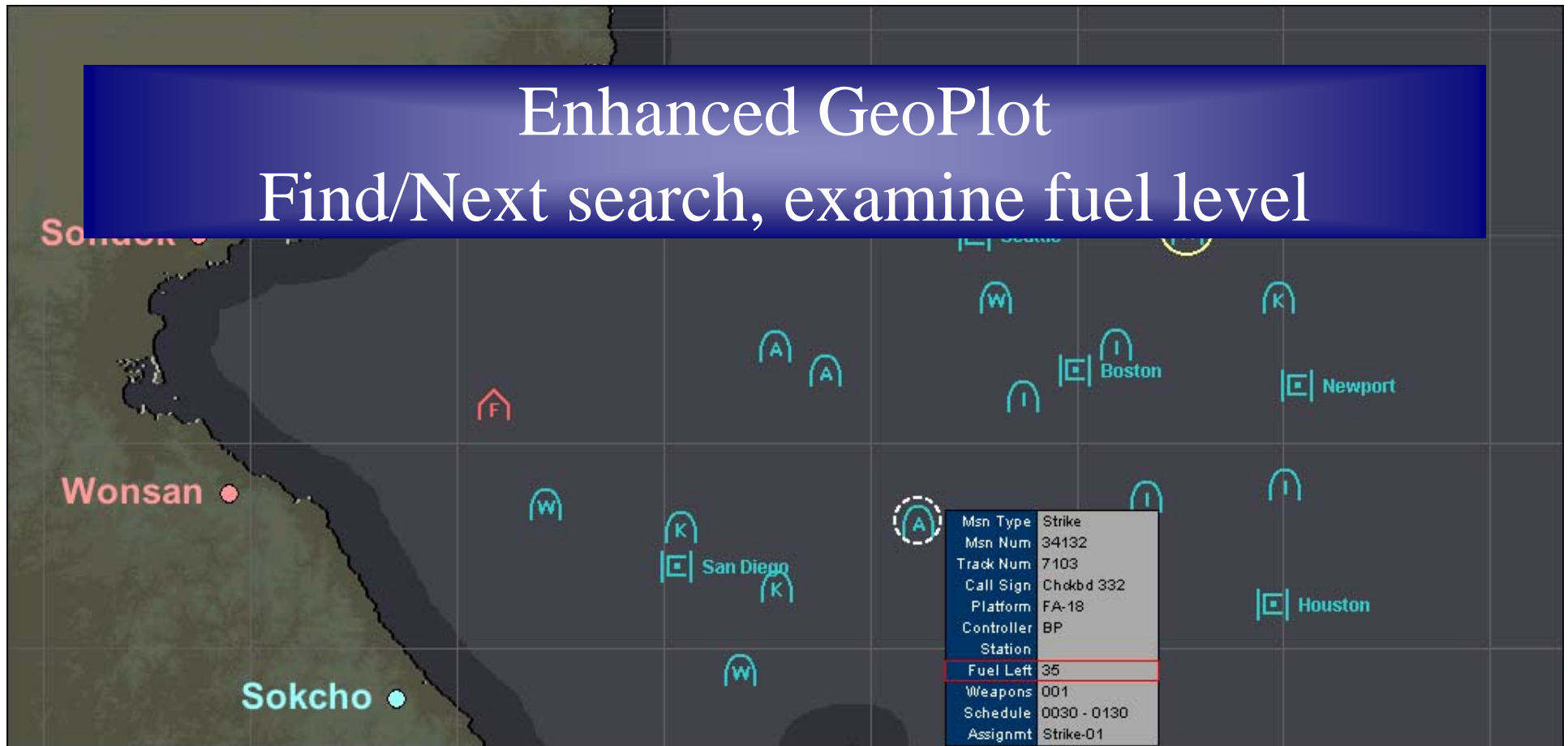
View: ☐ AEW ☐ DCA ☒ Strike ☐ Tanker

Mission Type	Mission Num	Track Num	Call Sign	Platform	Controller	Station	Fuel Remaining (%)	Weapons	Schedule (Z)	Assignment
Strike	34132	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01
Strike	33258	7117	Chokbd 326	F-14	BP		75	120	0300 - 0450	Strike-01
Strike	33118		Chokbd 327	F-14	BP		70	111	0230 - 0400	Strike-01
Strike	34067	7154	Chokbd 331	FA-18	BP		65	122	0130 - 0330	Strike-01
Strike	34132	7103	Chokbd 332	FA-18	BP		35	001	0030 - 0130	Strike-01

Where is the Strike aircraft with the lowest fuel level?

Enhanced GeoPlot

Find/Next search, examine fuel level



AEW

DCA

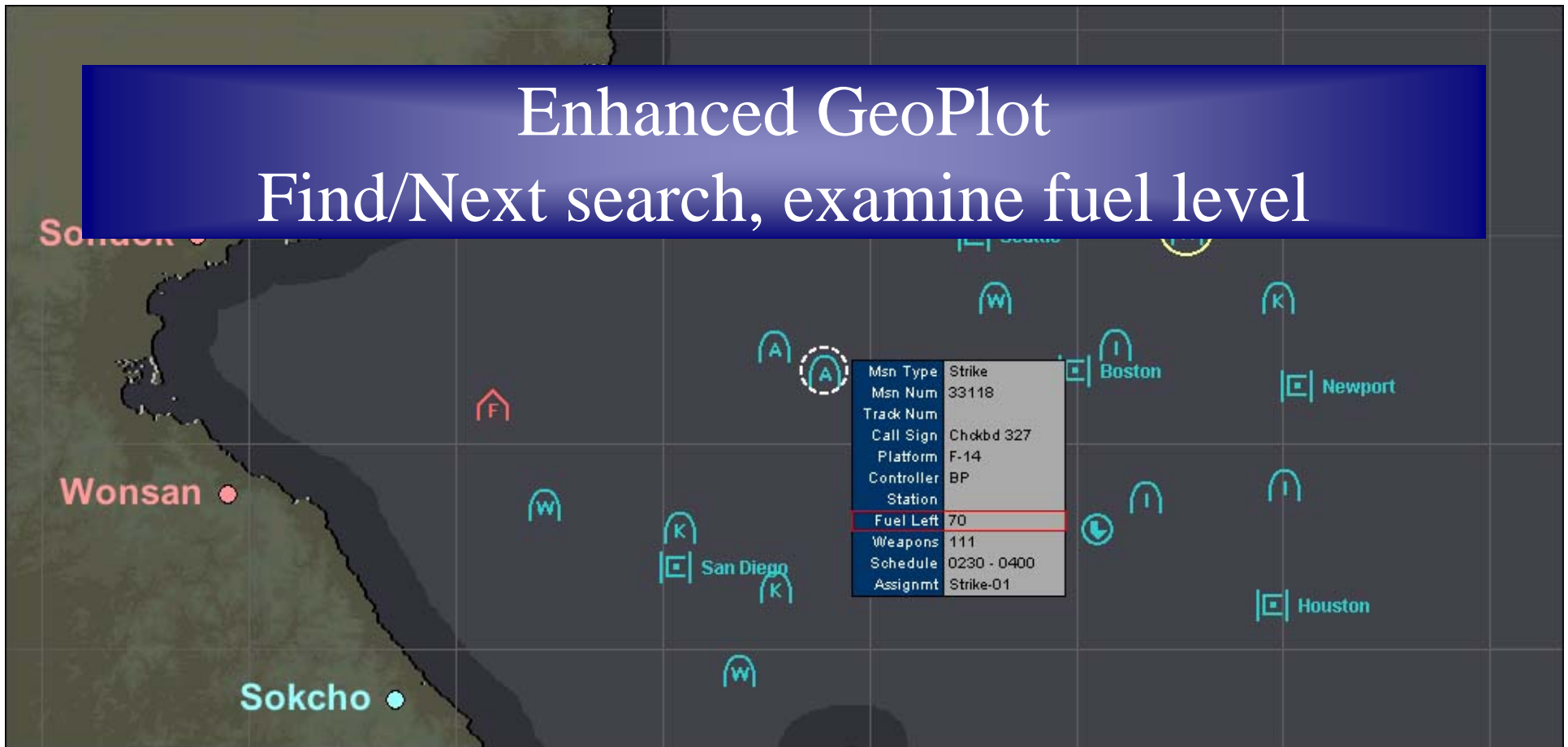
Strike

Tanker

Where is the Strike aircraft with the lowest fuel level?

Enhanced GeoPlot

Find/Next search, examine fuel level



AEW

DCA

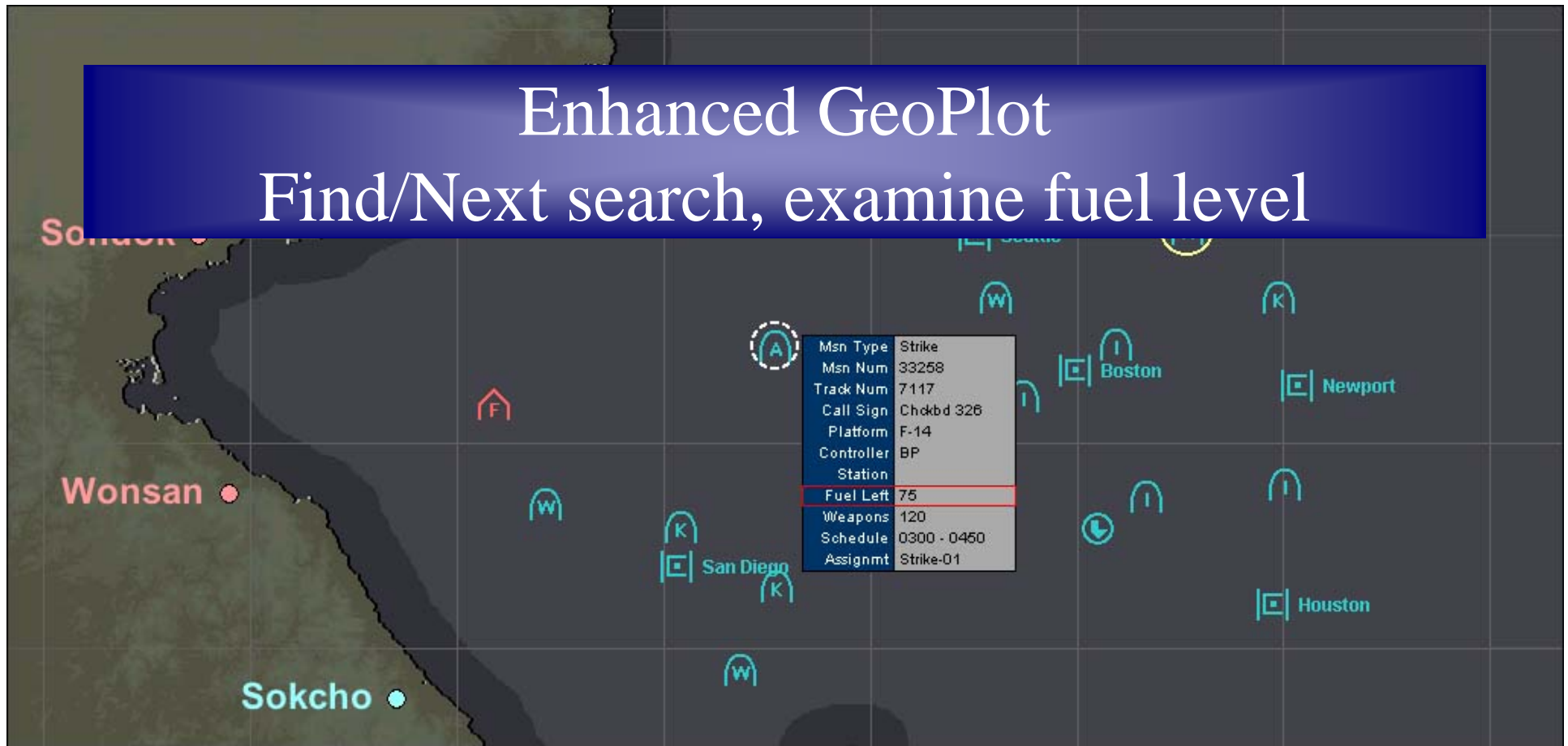
Strike

Tanker

Where is the Strike aircraft with the lowest fuel level?

Enhanced GeoPlot

Find/Next search, examine fuel level



AEW

DCA

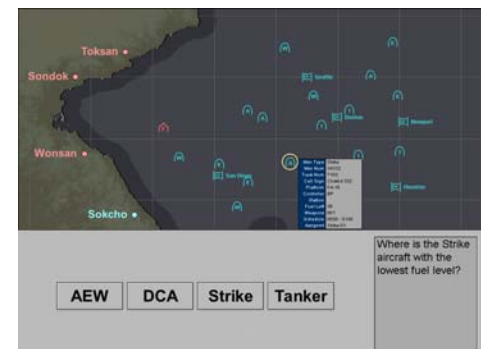
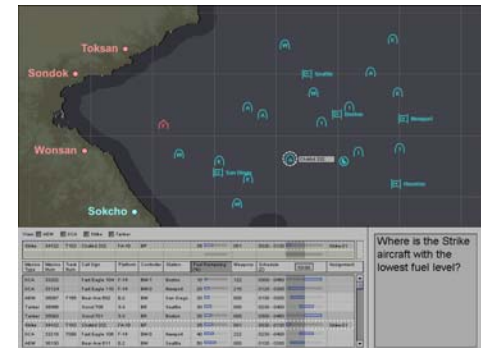
Strike

Tanker

Where is the Strike aircraft with the lowest fuel level?

Design Alternatives for Showing Attributes

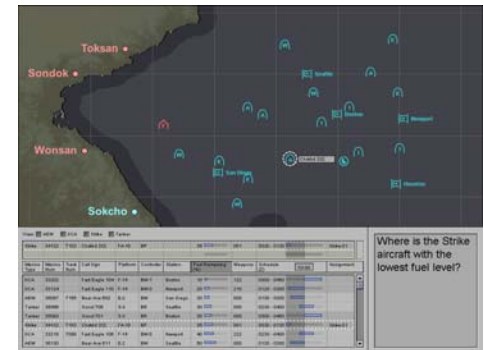
- ◆ Resource Grid
 - Tabular and spatial organizations
 - Dynamic visual linking
 - But two displays
- ◆ Basic Geoplot plus pop-up list
 - Spatial organization only
 - Single, integrated display
 - But search is difficult
- ◆ Enhanced Geoplot
 - Spatial organization only
 - Single, integrated display
 - Find/Next search
 - Still one-at-a-time display



Example Questions from the Experiment

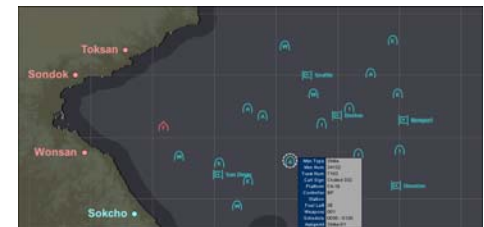
- ◆ Data-based search vs. map-based search

- Where is the aircraft that is closest to the carrier?
- What is the platform of the aircraft with track number 7022?



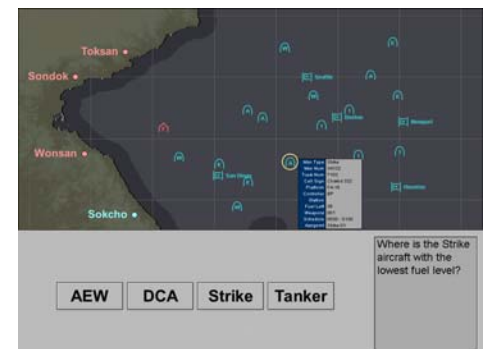
◆ Single attribute vs. comparison

- Where is the Strike aircraft with call sign Checkerboard 327?
- What is the call sign of the aircraft with the lowest fuel level?



- ◆ Single mission vs. all aircraft

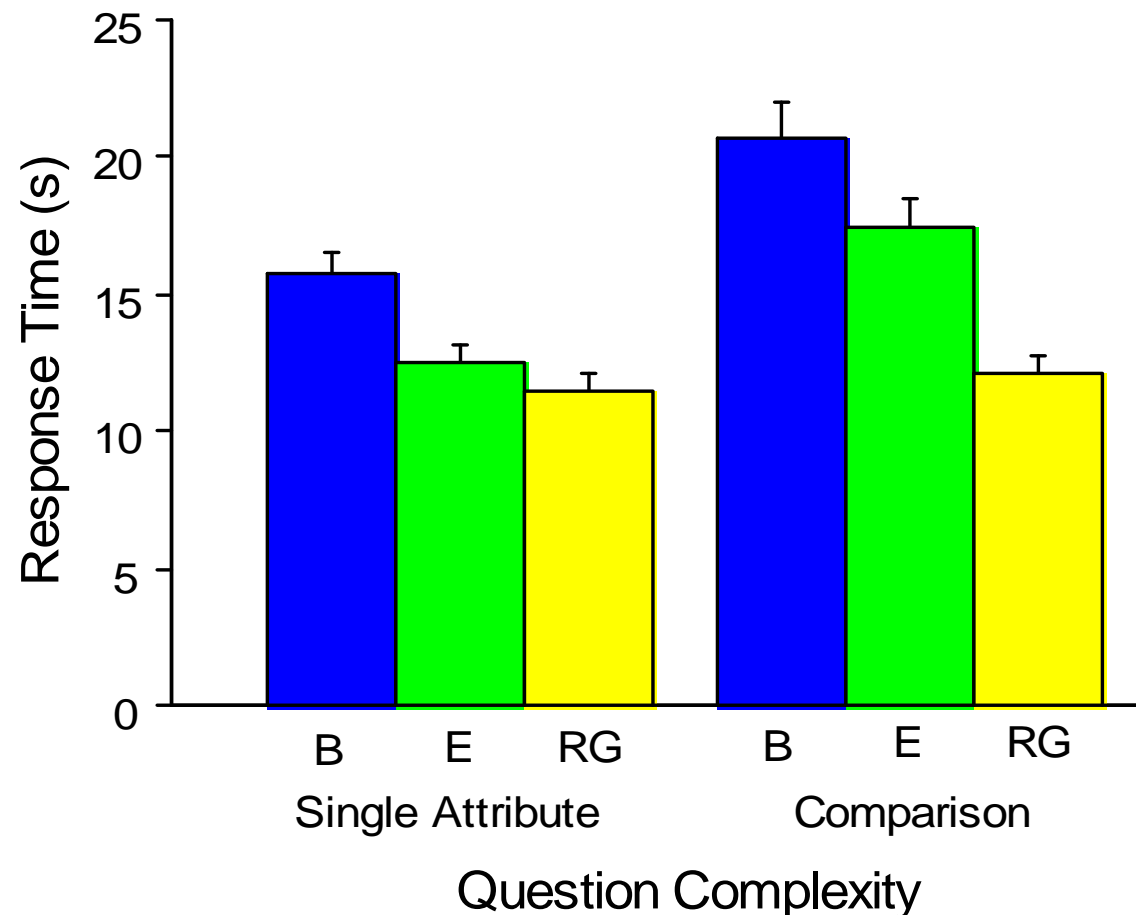
- Where is the (DCA) aircraft with the fewest weapons?



Comparisons Among Assets

Where is the strike aircraft with the lowest fuel level?

- ◆ Comparisons were slower than Singles
 - E.g. Searching the geoplot and remembering previous values
- ◆ Except for RG
 - Sorting and comparing down a column
- ◆ For comparisons, RG was 42% faster than Basic



Conclusions

- ◆ Active tables for asset/attribute comparisons
 - Filter-able, sort-able, scan-able tabular display
- ◆ Architecture principle: “Slice and Link”
 - Multiple 2D displays, plus
 - Dynamic Visual Linking
- ◆ Military command and control is a rich domain for investigation of collaboration principles and innovative visualization concepts
- ◆ Many of these principles and concepts apply to multiple domains

